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How to Achieve a Green and Sustainable Recovery from the Covid-19 Crisis?

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Abstract

Since the beginning of 2020, the world has been facing two global crises simultaneously: the acute Covid-19 pandemic and the climate crisis that is gradually expanding. The recovery from the pandemic crisis gives an opportunity for governments to contribute to climate goals and avoid going back to fossil fuel-based systems that are dependent on exhaustible sources of energy. Climate change increases even further the risk of infectious diseases in the future due to rising temperatures. This literature review analyses the effect of the pandemic on the economy and the environment. The focus is especially on how the recovery measures from this economic and social crisis can be designed to be green and sustainable. The effectiveness of such policies can be analysed by the fiscal multiplier model.

Growing unemployment and exceptional stimulus measures by governments increase the public debt burdens which creates challenges to recover economies. These key policy challenges can be overcome if green recovery measures could support employment, increase governments' fiscal space and have high fiscal multipliers while supporting the shift towards carbon neutrality. The analysis suggests a broad set of policy measures, carbon pricing, green infrastructure investments and conditional bailouts, that could help achieving an environmentally friendly and sustainable recovery from the Covid-19 crisis.

Keywords Covid-19, climate change, environmental economics, economic crisis, fiscal multiplier

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1 Introduction

Since the global outbreak of Covid-19 in the beginning of 2020, the world has been facing two crises. First, the pandemic crisis that instantly caused an exceptional economic downturn and a globally spread health risk. Secondly, the climate crisis that has started to create visible economic impacts and lead to the possibility of systemic risks, if not managed. Both of these crises are global by character and will therefore require international efforts while the impacts are not evenly allocated between countries and regions. In addition, the two crises have many other similarities such as market failure, need for public intervention and doubts about the resilience of current structures that favour fossil-fuel based industries (Hepburn, O'Callaghan, Stern, Stiglitz & Zenghelis, 2020). This thesis examines the global economic impacts of the two crises and the possibility to manage both of them simultaneously, as well as the interconnections between policies that aim to manage these two crises.

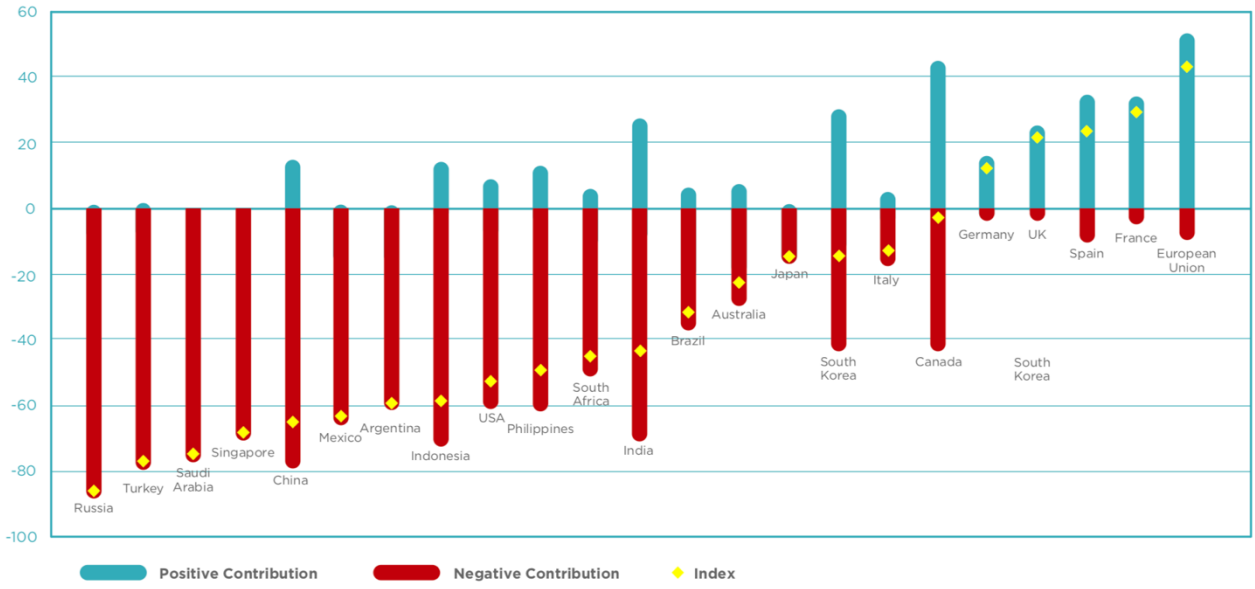

Figure 1 The Greenness of Stimulus Index (GSI) (Vivid Economics, 2020)

Figure 1 reflects the positive and negative contributions of stimulus measures to the environment in world's largest economies. These measures, announced by October 2020, have had mostly negative impacts on climate. In the large developed economies only the United Kingdom, France, Spain and Germany have a positive index. For the United States and the large emerging countries, especially China and India, the index is clearly negative. For the time being, most governments in general seem to have failed to use recovery policies that would support climate goals, especially those set by the Paris Agreement in 2015 (Vivid Economics, 2020). The agreement includes long run low greenhouse gas emission development strategies. For example, to meet the objective of climate neutrality by 2050

in line with the Paris Agreement, the European Union endorsed a binding target to reduce greenhouse gas emissions by 2030 compared to 1990 by at least 55 percent (European Council, 2020) in parallel with the measures to address the pandemic. This can be clearly observed in figure 1.

The current response to the pandemic seems to be supporting the pre-existing structures that are dependent on stranding sources of energy. This will contribute to rising temperatures, which could further increase the risk of infectious diseases and climate related risks (Stern, 2011, p. 86-89). The Covid-19 pandemic has shown the damages that can occur to the economy and human welfare if the climate emergency is not dealt with. The fiscal recovery packages that have been introduced amount to 13 trillion US dollars (Vivid Economics, 2020). These packages, with the many still to come, are expected to shape the future of the economy and the climate for the coming decades. Therefore, these packages are relevant in transformation to greener and more sustainable economies (Bhattacharya et al.,2020).

The research question of this thesis is quite recent. There is no published academic research on the topic yet. However, research on climate policy (see, e.g., Hepburn, 2006) and on fiscal stimulus in times of crisis (see, e.g., Romer, 2009) exists, but there is a lack of research in combining these two areas. This thesis aims to analyse the two aspects by answering the question “How to achieve a green and sustainable recovery from the Covid-19 crisis?”.

This literature review focuses on the global recovery measures of governments. It aims at identifying recovery policies that support employment, economic growth and public finances, while at the same time contribute positively to climate goals. The fiscal stimulus during an economic crisis is typically financed by new public debt. The rising unemployment and decrease in production have negatively affected public revenues, which can create challenges for governments to service their debt. Recovery measures to manage such a crisis refer to a package of different policies. The key policy measures discussed in this paper are carbon pricing (e.g., carbon tax), green infrastructure investments and conditional bailouts. In addition, the thesis examines the theoretical basis of fiscal multipliers to support the reasoning of policies suggested.

This paper proceeds as follows. Section II describes the economic and environmental effects of the pandemic. Section III discusses the design of green and sustainable recovery measures by using the fiscal multiplier model. Section IV analyses specific policy instruments available that could be used to recover from the pandemic crisis in a green and sustainable way.

2 Impacts of Covid-19 on the economy and the environment

The Covid-19 pandemic has had immediate negative effects on growth. Before the pandemic started to spread, the global economy was estimated to increase by 3 percent in 2020. However, the pandemic caused an exceptionally deep economic shock. The magnitude of decline is country specific, but the global growth projections refer to a drop of approximately 4 to 5 percent in 2020 (World Bank, 2020). Nevertheless, there is a silver lining to these negative economic impacts. So far, carbon dioxide emissions have fallen by 8 percent in 2020, which is more than during the global financial crisis in 2008-9 (Hepburn et al., 2020).

2.1 Global impacts on demand and supply

After the pandemic spread to countries all around the world, governments started to constraint mobilization through lockdown measures. These measures have led to negative shifts in the aggregate demand and supply curves, which has decreased the global gross domestic product and economic activity in general (World Bank, 2020). General uncertainty, unemployment and layoffs have increased while income, world trade and production have declined (Koundouri, Pittis & Samartzis, 2020).

The global demand has fallen due to various reasons. First, the prevailing uncertainty affects the decisions of all economic actors. As long as consumer and business confidence is low, overall demand is affected. This leads to more cautious spending, postponement of investments and additional savings. Secondly, due to an immediate rise in unemployment and furloughs, disposable income has decreased and created unexpected constraints for consumption (Hepburn et al., 2020). Lastly, the restrictions in mobility have directly affected demand. For instance, the travel industry and other connected sectors suffer as policymakers try to stop the virus from spreading. Demand in these sectors has fallen as quarantines have prevented or limited consumers from using these services (Maliszewska, Mattoo & van der Mensbrugghe, 2020).

The global supply shock is a result of the pandemic. International trade has suffered from supply chain disturbance. The disruptions create constraints for firms' production globally (Koundouri et al., 2020). In addition, the economic impacts spread from one country to another through global supply chains. As the global economy is strongly inter-linked, the virus has undermined the whole world's health and economy at once (Maliszewska et al., 2020).

2.2 Public sector

2.2.1 A rise in public spending

Countries globally have been forced to expand the capacity of healthcare in the short-term. Saving lives has been the first policy priority for governments, which has required supplementary equipment, training and testing in the health sector. The severity of symptoms and the rate at which the pandemic is spreading determine the demand for healthcare and the need for additional capacity. Also, research and development for Covid-19 vaccines and drugs have increased the health-related costs for governments (Dudine, Hellwig & Jahan, 2020).

In addition to supporting human welfare, fiscal stimulus measures have been needed to support employment and ease financial distress of households and companies. These measures have included direct subsidies, tax reductions and deferrals, temporary liquidity measures and loan guarantees (Koundouri et al., 2020). Households have been given direct financial support, especially those with low-income, and extensions in different benefits such as unemployment benefits to guarantee liquidity during the crisis. Small and medium enterprises, under economic distress due to the pandemic, have been supported by postponements on rent and cuts or deferrals on taxes. Additionally, they have received direct transfers to pay wages and other necessities. Furthermore, companies have received subsidized public loans or state guarantees for their loans. Some larger companies are also being bailed out by governments, with or without conditions, to avoid bankruptcy (Freire-González & Vivanco, 2020).

2.2.2 Impacts on public debt

According to the International Monetary Fund (IMF), the advanced countries suffered from high debt-to-GDP ratios already in 2019 before the Covid-19 crisis. For example, in Japan the ratio was 238 percent, in Greece 181 percent, in Italy 135 percent and in the United States 106 percent. In the emerging markets and developing countries the debt-to-GDP were not nearly as high as in the advanced ones. For instance, in Colombia the debt ratio was 49 percent, in South Africa 62 percent and in the Philippines 42 percent at the end of 2019 (Trading Economics, n.d.).

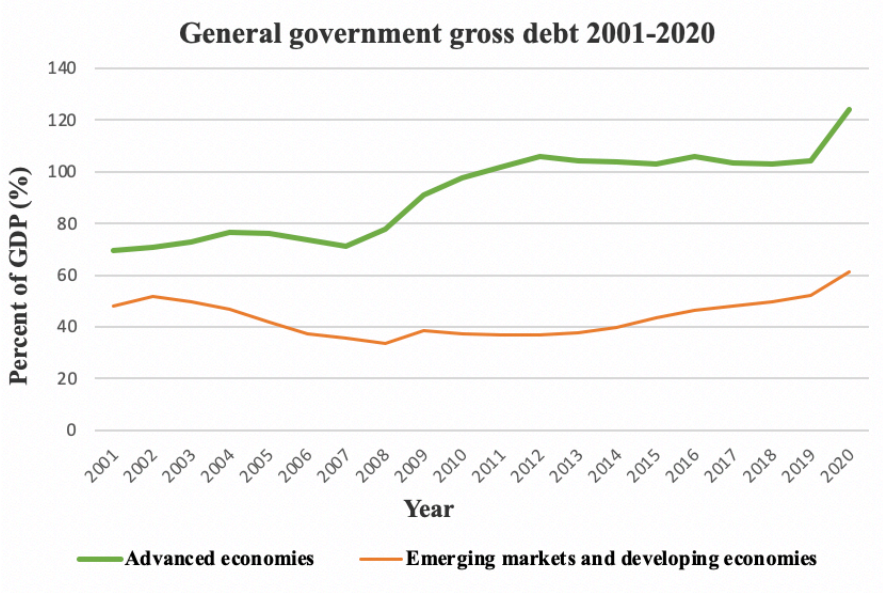

Figure 2 General government gross debt 2001-2020 (International Monetary Fund, 2020)

Government intervention through lockdown measures have caused immediate unemployment, furloughs and production disruptions that have negatively affected public finances. By October 2020, governments had announced 13 trillion dollars in stimulus packages to address the current crisis and to recover economies. This will increase public debt especially in the short run (Vivid Economics, 2020). The IMF has gathered data concerning economies' general government gross debt levels from 2001 to 2020. Figure 2 indicates that the debt-to-GDP ratio of advances countries (green line) has steeply increased in 2020 due to the on-going pandemic and debt-based public spending. In the emerging and developing economies (orange line) the rise in debt levels has been more subtle, but the trend is upwards. In addition, in both cases the debt levels are currently higher than during the financial crisis of 2008-9. The pandemic crisis seems to have affected public finances more seriously than the previous crisis, as figure 2 denotes. High debt burdens will keep countries vulnerable to new negative shocks in the future (Bhattacharya et al., 2020).

Even though the increase in the debt-to-GDP ratio in the emerging markets and developing countries was not as large as in the advanced economies, the increase can still be problematic (Koundouri et al., 2020). The emerging and developing economies are more vulnerable to shocks. These countries are more affected by the decline in prices of raw materials, cashflows from developed countries and tourism caused by the pandemic. In addition, emerging and developing economies are more impacted by the tangible effects of climate change, such as intensified typhoon seasons in Asia and the Pacific,

which has also increased public spending. Therefore, these countries will possibly need new sources of public revenue, like carbon taxes, to acquire more fiscal space (Bhattacharya et al., 2020).

2.3 Financial markets

The pandemic has inevitably also affected the financial markets. Stock markets have been driven by the general uncertainty and country specific circumstances. For instance, in the United States, the European Union and China stock prices dropped instantly over 30 percent on average due to negative macroeconomic shock when the virus spread to these areas. The recovery of stock prices seems to be dependent on the ability to manage the pandemic together with stimulus measures. The more recent recovery reflects the progress made with the vaccine (OECD, 2020a). The economic uncertainty is also seen in the increasing volatility of exchange rates. Investors have sold risky assets and acquired more liquid and safe assets like bonds instead. Also, the decline in oil prices due to decreased demand, accelerated the drop of stock markets (Ioannou & Wójcik, 2020).

However, the recovery of financial markets was supported by the intervention of central banks and governments who ensured short-term liquidity and reduced the negative economic shock. The European Central Bank (ECB) pursued to stabilize and strengthen the Euro with asset-purchase programs. The US Federal Reserve (FED) lowered interest rates by 0.5 percent and bought bonds to aid the market affected by the pandemic (Agha et al., 2020). Like the ECB and the FED, the Bank of England has also focused on quantitative easing by announcing to buy government bonds to stabilize the economy (Ioannou & Wójcik, 2020). These measures, together with the fiscal stimulus measures discussed above and the exceptionally low interest rates, have stabilized financial markets after the initial shock.

2.4 Businesses

Globalization has made businesses more dependent on each other through global supply chains and international trade. The pandemic has brought to light the negative impacts of this inter-dependence. Reductions in demand due to quarantines have decreased production and cashflows across a range of different sectors, particularly the travelling and aviation sector. This has created challenges in some businesses' activity and ability to pay wages and back loans, especially for smaller enterprises. Therefore, firms have had to use undesirable measures by firing and furloughing their staff (International Labour Organization, 2020). These difficulties have increased the risk of bankruptcy and the need for financial support. While firms around the world have faced the same difficulties,

export and supply chain disruptions have arisen. In addition, lower household incomes and reduced production have declined the volume of import (Maliszewska et al., 2020).

As a result of the general uncertainty, companies invest less (Koundouri et al., 2020). The increased risks of profitability cause postponements of investment decisions and new projects. The durability of the pandemic affects risk appetite of enterprises. In times of crisis, investors tend to focus more on safe assets, and therefore invest more in developed economies (Bhattacharya et al., 2020). However, large companies have better access to financing than smaller firms. This can be harmful for the environment for example in the European electricity sector, where largest firms' innovations are typically based on fossil-fuel technologies. This means that fossil-oriented firms might be favoured in the recovery process if they have leading market position in the sector (Engström et al., 2020).

Underutilization of labour and capital has led to a decrease in total global production (Maliszewska et al., 2020). As production and demand have decreased, oil prices have shrunk from 25 euros to a range of 15-20 euros (Ember, n.d.). On the positive side, this drop in fossil fuel prices has worked as a stabilizer for companies in anguish. However, lower oil prices give incentives to use fossil fuels in production which do not support the transition towards carbon neutrality. For this reason, businesses focusing on green and sustainable growth may be weakened in the short run (Borghesi, Delbeke, Glachant, Pototschning & Ranci, 2020). A slowdown in the number of deaths caused by the pandemic stabilized oil prices temporarily, but there is still much uncertainty about the future (Agha et al., 2020).

2.5 Workforce and consumers

The pandemic has increased the rate of unemployment significantly. During the first three quarters the rate has more than doubled to over 11 percent in the OECD countries. The unemployment during the second wave of the virus over the last quarter of 2020 and in 2021is projected to increase to almost 13 percent (OECD, 2020b). In April 2020, 81 percent of the world's workforce lived in countries where the lockdown measures had affected their workplace (ILO, 2020). The crisis has impacted the workforce all around the world and consequently consumers (Hepburn et al., 2020). Work-from-home policies make it possible for some sectors to continue their everyday work but poses challenges to others for instance airlines, tourism and accommodation services.

On the demand side, consumers are spending less due to decreased income, uncertainty about the future of purchasing power and limited consumption possibilities (Hepburn et al., 2020). Layoffs and unemployment have declined the number of aggregate working hours (ILO, 2020). Many individuals

face financial distress because of losses in income, which creates constraints to consume and repay loans. This means that money is more likely used to buy necessities than other goods. Also, these unusual circumstances and the risks of getting infected create insecurities which may increase the willingness to save. Moreover, lockdowns have narrowed down consumer's possibilities to use their income. Travelling, using face-to-face services such as restaurants and hairdressers or doing experience-based activities, like going to a concert or to the theatre, are restricted to avoid the virus from spreading (Maliszewska et al., 2020).

2.6 Environmental effects

These negative shocks in the economy have led to less consumption and less production, and thus declined the carbon dioxide emissions. The decrease in greenhouse gases is mainly a result from less air traffic, trade, transportation as well as the shutdown of factories that affect directly the use of fossil fuels. The decline in household consumption has for example dropped the European greenhouse gas emissions by 45 percent, being the most important part of aggregate demand that has affected the environment. In addition, there has been less mobility caused by the confinement and the restrictions to travel. Globally, the decline in private mobility is representing 18 percent of the total drop in emissions in 2020. For the aviation sector, the fall is equal to 7 percent of the total decline in emissions emitted. Based on evidence, the overall fall in investments has led to carbon emission reductions in smaller developed countries (Cazcarro, Duarte, Sarasa & Serrano, 2020). The shift to remote work and changes in consumption habits, as well as, suspensions of flight routes are examples of behavioural changes, caused by the pandemic that appears to have advantageous impacts on the environment. It is still uncertain which of these changes could be long-lasting.

Even though the dramatic decrease in economic activity has brought down emission levels, the eight-percentage decline of greenhouse gases should be repeated for many years to come to reach many governments' commitment to achieve carbon neutrality by 2050. Eventually, the quarantines will end, the economy will awake, and emissions will likely rebound. Nevertheless, the extent of the rebound is closely connected with the rate of economic recovery, the nature of government's recovery spending and the magnitude of rebound in consumer consumption. With no policy change, economies would maintain the status-quo, and this would lead to a failure to meet the objectives to mitigate climate change. The recovery packages will therefore shape the post-pandemic world which includes the future of climate actions (Hepburn et al., 2020).

3 The design of green and sustainable recovery policies

Crises involve opportunities to introduce policy-changes and modify behaviours. Therefore, the phrase "never let a good crisis go to waste" is often used in these kinds of circumstances. The challenge is that policymakers are facing multiple objectives with urgent needs concerning people's health, the economy and the environment. The key policy challenge is how to combine these objectives. If designed carefully, the recovery measures could at the same time stabilize the economy and achieve long-term environmental targets (Engström et al., 2020). This section discusses how these objectives could be met by using the fiscal multiplier and analysing the challenges of policy design.

3.1 The challenges of designing green and sustainable recovery measures

In times of crisis, the main targets of governments' stimulus policies are to restore the confidence of economic actors and stabilize the economy. Optimally, fiscal stimulus packages should be targeted, timely and temporary and at the same time avoid negative impacts. Nevertheless, multiple challenges will have to be overcome in the design of policy measures for them to be successful in the medium and long run, as well as in the short run. The key challenge of stimulus policy design is how to reach efficiency in terms of delivering economic and climate outcomes (Hepburn et al., 2020).

A number of components, such as speed of implementation, fiscal multipliers, trade-offs, flexibility and effects on equality and the environment, will affect the efficiency of stimulus measures (Hepburn et al., 2020). In addition, it would be effective if these recovery policies not only addressed the ongoing pandemic, but also reduced the threat of future pandemics and the damages of climate change. By creating change in economic systems, societies could gain resilience against current crises and stop favouring polluting energy (Koundouri et al., 2020). Stimulus measures can be successful if in the short run economic activity could be restored and in the long run structural changes could be made and carbon neutrality goals could be achieved (Bhattacharya et al., 2020).

One key policy challenge concerns financing, especially in the context of weakened fiscal positions. Therefore, the access to green finance and the support of multilateral financial institutions becomes relevant. International aid and assistance are likely needed especially in developing countries in the finance, design and implementation of recovery policies for the shared goals to be achieved (Bhattacharya et al., 2020).

Flexibility is also a key element in designing stimulus measures. While the development and length of the health and economic crisis stays unknown, governments should be prepared to make rapid

adjustments. Flexible responses would allow the economy to stabilize more automatically without necessarily the repeated need for legislative action (Stiglitz, 2020).

During economic crises, the focus is usually on larger-scale projects that might have bigger transformative effects. However, these kinds of projects would have had to be designed already before the crisis for them to begin in the near future. It will take time to go through all the steps of new large but more sustainable and green projects. In many cases sustainability is not yet implemented in the planning, purchase, materials and construction parts of infrastructure investments for instance. Therefore, the pandemic has created the possibility to add the green aspect into new projects. Cost efficiency, labour intensity and careful examination of future returns of investments could help to deal with governments' budget deficits as tax revenues have decreased (Bhattacharya et al., 2020).

Designing green recovery measures may create challenges for countries in terms of trade-offs between climate policies and employment in fossil-fuel-based industries and affordability of energy. Labour in carbon-intensive industries is likely to decrease and create socially inequal treatment if the policies are not well designed. These trade-offs and growing unemployment rates can possibly create incentives to focus on designing green projects later on when the economy is in a more stable state. However, climate change is a pressing crisis that can have even more severe consequences than Covid-19 if the crises are not addressed simultaneously (Bhattacharya et al., 2020).

3.2 The fiscal multiplier

3.2.1 The multiplier model

The effectiveness of recovery policies can be analysed by the fiscal multiplier model. The fiscal multiplier is a macroeconomic mechanism first introduced by Keynes (1936) that demonstrates the relation between changes in government spending or reductions in taxes and the gross domestic product (The CORE Team, 2017, Unit 14.2).

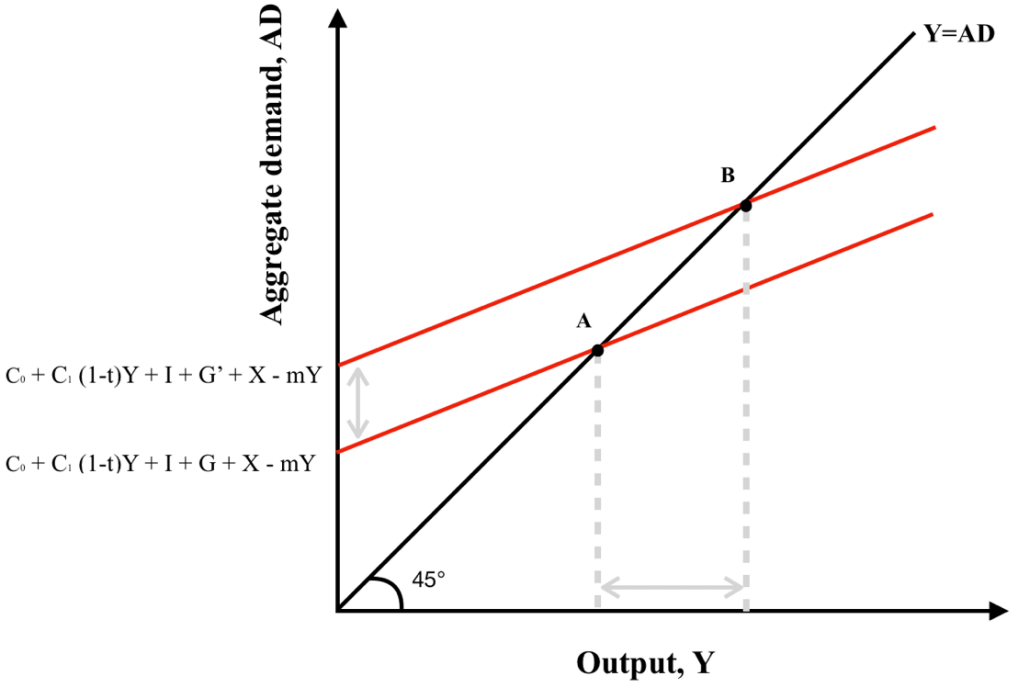

Figure 3 The Multiplier Model (The CORE Team, 2017, Unit 14.2)

The multiplier model shown in figure 3 illustrates this macroeconomic mechanism. In this model, aggregate demand consists of consumption, investments, government spending and net export. $C_0 + C_1$ (1-t)Y reflects the spending on consumption. (1-t)Y is the disposable income or in other words the post-tax income. C_1 is the marginal propensity to consume and C_0 describes all the impacts on consumption excluding disposable income. G stands for government spending and I for investments. The last part of the equation X – mY is the net export. The exports (X) decrease as the marginal propensity of import (m), which describes the fraction of income that is used on imports, increases. Figure 3 illustrates that as government spending increases, the change in output is greater than the initial change in government spending. This mechanism is called the fiscal multiplier (k) (The CORE Team, 2017, Unit 14.5).

$$k = \frac{1}{(1 - C_1(1 - t) + m)}$$

This equation helps explaining the larger increase of the gross domestic product compared to the initial change in government spending and the mechanism of the multiplier in times of economic crises (The CORE Team, 2017, Unit 14.5). Estimates on the size of the multiplier have been quite similar across forecasters. In most simulations, a cut in taxes has been estimated to have a fiscal multiplier of 1.0,

one and a half years after the initial change, and public spending a larger multiplier of approximately 1.6 (Romer, 2009). Auerbach and Gorodnichenko (2012) indicated in their study that fiscal measures are most effective in recession meaning that the fiscal multiplier increases. For instance, during the recession in 2009, a one US dollar increase in government spending could raise output by approximately 1.75 dollars (Auerbach & Gorodnichenko, 2012). This can potentially be explained with the propensity to consume (C_1) and to import (m). Typically, in a recession, households' disposable income decline which can increase the propensity to consume (C_1) if savings rates are low. Liquidity-constraints can increase the probability of spending the money available due to revenues being smaller (Charles, Dallery & Marie, 2015; Romer, 2009). This effect can therefore increase the value of the multiplier (k). The propensity to import (m) tends to react differently. Investments have a tendency to decrease more than other factors in the aggregate demand during recession. As investments typically contain the largest share of imports, the share of imports in the gross domestic product decreases (Bussière et. al., 2013). This can lead to a bigger fiscal multiplier as a smaller share of public spending goes to other countries (Charles, 2016).

3.2.2 Uncertainties about the size of fiscal multipliers

The fiscal multiplier of fiscal stimulus during the financial crisis of 2008-9 was higher than expected (Auerbach & Gorodnichenko, 2012) but it may not be the case in this crisis. In the pandemic crisis, recovery spending may have smaller fiscal multipliers due to various reasons having to do with uncertainty. Firstly, the duration of the pandemic remains unsure. Economic actors may be cautious as Covid-19 can have several waves. Saving might be more tempting for individuals and firms. Therefore, due to precautionary economic actions, the propensity to consume may stay low even though disposable income has declined (Bowen & Stern, 2010). Secondly, Covid-19 is a health risk that creates concern in consumers. Expectations may be less affected by government intervention and more by the development of the pandemic itself. The public efforts to recover the economy may be less effective if people are reluctant to travel and consume social activities under the fear of getting infected. Lastly, the main challenge for policymakers is channelling public spending to the right targets, in other words, knowing where the propensity to consume is high and at the same time where the aid would be used most sustainably (Stiglitz, 2020). Furthermore, country characteristics play an important role in the magnitude and performance of fiscal multipliers (Bhattacharya et al., 2020). The size of these multipliers usually increases when countries are bigger, developed or closed. In addition, lower debt-to-GDB ratios and fixed exchange rates are commonly associated with higher fiscal multipliers (Ilzetzki, Mendoza & Végh, 2011).

3.2.3 Combining fiscal multipliers with climate goals

The multiplier model discussed in the previous section does not capture the impact of stimulus measures on climate. The main goal of fiscal measures in the pandemic crisis is to save lives and keep the economy functional. A broad selection of policy measures can be considered to achieve these goals. In the following, the potential impacts of these measures on climate will be considered on the basis of a survey.

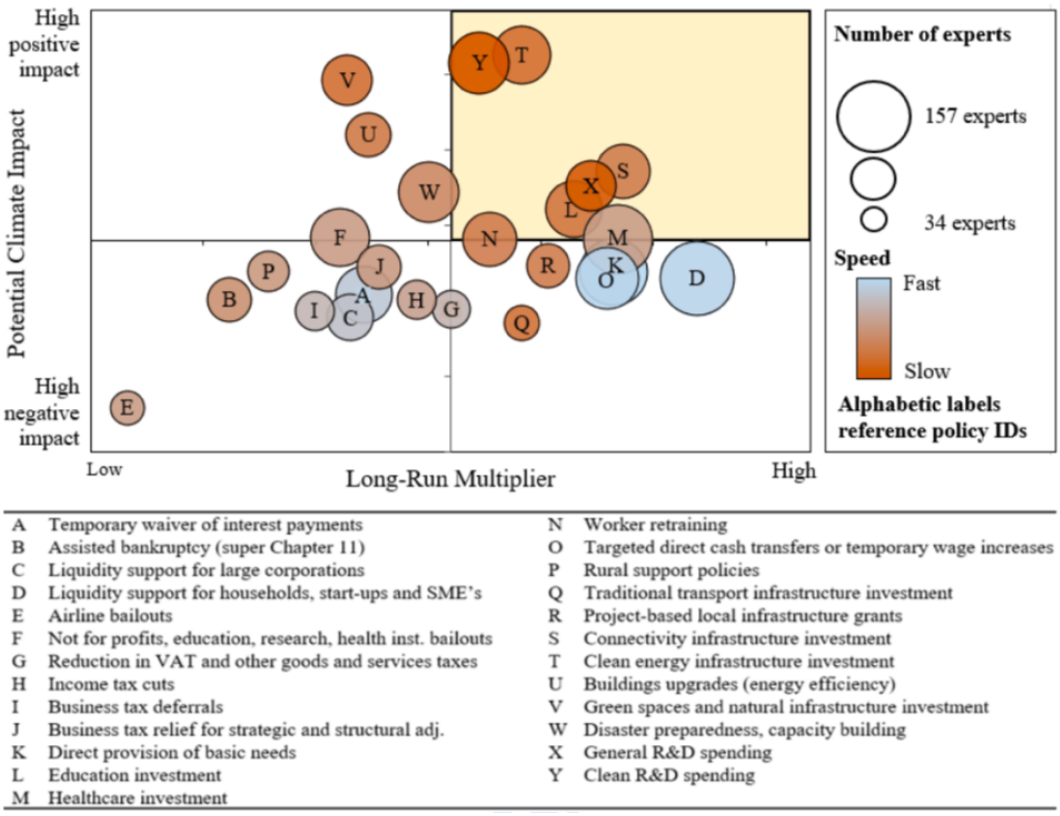

Figure 4 Target group mean survey results aggregated using relativity-adjusted scores (Hepburn et al., 2020)

Figure 4 reflects a survey made in April 2020, where 231 economists from 53 different countries were asked about their views on the fiscal recovery measures. This figure shows different types of recovery policies (every letter reflects one policy) and where they stand on the axes in terms of the nature of potential climate impacts and the magnitude of the long run multipliers. Also, the colour of the circle indicates the speed of implementation of each policy. The measures with the highest positive environmental impacts are clean energy infrastructure investments (T) and clean research and development spending (Y). The long-term multipliers are the highest for liquidity support for households and small and medium-sized enterprises (D) and healthcare investments (M). Airline bailouts (E) had the lowest multipliers and the most negative climate effects. This would imply that

green policies have higher multipliers than traditional fiscal measures, which can be explained by lower long-term energy costs. It is still important to acknowledge that not all green stimulus measures are efficient as stimulus tools (Bowen & Stern, 2010). Regarding this survey, one should also acknowledge that the results can be biased due to the climate change beliefs of the answerers (Hepburn et al., 2020).

The increase in unemployment rates and distress of firms, especially small and medium-sized enterprises that may have more difficulties to get loans, should be addressed to support the economy. This can be done with direct financial aid, tax deferrals and offering government guarantees for loans. Governments have the possibility to support green firms that would shift the production and incentives in a less polluting direction. Fiscal stimulus spent on private research and development, particularly in the green energy sector, can also help avoiding bankruptcies and the suspension of flourishing research teams (Engström et al., 2020). As figure 4 denotes, policies regarding liquidity support for small and medium-sized enterprises have high multipliers in the long run and these stimulus measures can be implemented fast. Because the currently planned fiscal packages are mainly funded by public debt, high fiscal multipliers of policies are needed to deal with policy challenges (Hepburn et al., 2020).

4 Specific policy instruments

This section analyses a set of concrete policy instruments that could support employment, economic growth and public finances, while at the same time contributing positively to the climate goals.

4.1 Carbon pricing

Carbon pricing refers to measures that put an appropriate price on carbon through taxes, trading or regulation. Greenhouse gases are in economic terms a negative externality. Putting an appropriate price on carbon means that producers of greenhouse gas emissions pay the cost of their actions themselves. Therefore, designing carbon pricing policy is aimed at reducing externalities of polluting firms (Stern, 2011, p. 349).

4.1.1 Weitzman's analysis in the context of carbon pricing

Weitzman (1974) analysed the efficiency of price and quota instruments when there is uncertainty about the costs and benefits of actions. In the context of climate change, carbon taxes, tradable allowances and their emission reductions can be studied by applying Weitzman's analysis. Combining

climate change and this theory has been done by Stern (2011) and Hepburn (2006). The magnitude of effects, the timing and the costs of abatements create uncertainty in the implementation of these policies. The figures below illustrate this scenario in the short and long run (Hepburn, 2006; Stern, 2011, p.354-357).

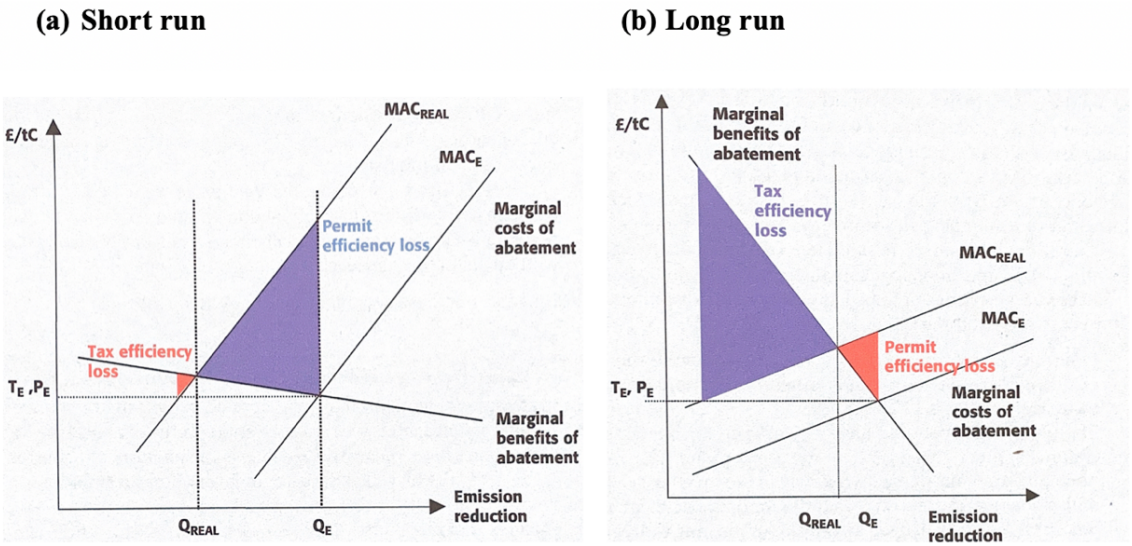

Figure 5 The efficiency of taxes and tradable allowances in climate-change mitigation (Stern, 2011, p.356-357)

Figure 5 reflects the efficiency of carbon taxes and tradable quotas in the short run. During a shorter period of time, for instance a year, the curve describing the marginal benefits of abatement is mildly decreasing or flat as the number of reduced emissions increases. This is because in a short period of time it is rather unlikely to have significant impacts on the total stock of greenhouse gas emissions. The curve illustrating the marginal costs of abatement (MAC) increases steeply when quantities increase as in the short-term it is challenging for companies to adjust their capital stock and technology in use to reduce greenhouse gases. When the costs of abatement are certain, policymakers should set the quantity of tradable quotas (Q_E) or the price of pollution (T_E) where the expected marginal costs of abatement (MAC_E) are equal to the marginal benefits of abatement. In this scenario, both instruments would be equally efficient because efficiency losses do not occur. However, this model also shows that when the costs of supplying are uncertain (MAC_{REAL}), the actual marginal cost curve differs from the expected one and both of these instruments are no longer efficient. As figure 5 indicates, when the curves cross at Q_{REAL} instead of Q_E, the efficiency loss from using the price instrument in the short run is smaller than the one from using tradable permits (Hepburn, 2006; Stern, 2011, p.354-357).

In the long run, the interpretations of the marginal cost curves and the marginal benefit curve differ from figure 5. In graph (b), the x- axis reflects the cumulative emission reductions and not the annual reduction like in graph (a). In addition, now the marginal benefit curve of abatements is decreasing more steeply than in the short run. As, when total emissions rise in the long run, the costs of the effects on climate change increase too. Also, the marginal cost curves are flatter in the long run because there is more flexibility for firms to adjust actions through implementing green technologies and replacing capital stocks. In this scenario, when the actual marginal abatements costs differ from the expected ones due to uncertainty, the use of taxes as an instrument is less efficient than the use of tradable quotas (Hepburn, 2006; Stern, 2011, p.354-357).

In conclusion from these graphs, efficiency of governments' decisions about which instrument to use will depend on the steepness of the marginal cost and benefit curves of abatement and the amount of uncertainty having to do with costs and benefits of abatement. When there is uncertainty about the cost and benefits of actions, carbon taxes are an efficient instrument in the short run and tradable allowances in the long run. Therefore, the outcomes indicate that it would be more efficient to use carbon taxes as a recovery measure in the short-term and implement an emission trading system in the long-term (Hepburn, 2006; Stern, 2011, p.354-357).

4.1.2 Carbon pricing in the recovery

A carbon pricing system could make stimulus packages more effective because fiscal space could be augmented by using inefficient fossil fuel subsidies, carbon taxes or tradable quotas for example (Engström et al., 2020). The low prices of fossil fuels during the pandemic have given incentives to use exhaustible sources of energy in production. This provides an opportunity to implement policies that can at the same time increase public revenues and make the use of fossil fuels less tempting. This could be done by including the damages of greenhouse gas emissions into the price of polluting energy (Bhattacharya et al., 2020).

First, phasing out inefficient fossil fuel subsidies that are damaging for the environment gives governments more funds to deal with the crises or to re-allocate the subsidies to green firms. Secondly, in terms of taxes, emitters can decide how much to produce with the global prices put on emissions. The taxes polluting industries have to pay directly become public revenue. Carbon taxes can also help creating incentives to spend on green investments and projects during the recovery. Thirdly, the continuous trading of tradable quotas sets the common price on the market once the total quota for

global emissions is determined. This kind of a trading system already exists in the European Union for example. However, tradable quotas can only raise public funds if the government sells the quotas through a direct sale or an auction. Also, this instrument may create efficiency loss in the short run as figure 5 suggests. But in the long-term, these policies can be effective when designed carefully and the frameworks of the policies are predictable and credible for investors that are making investment decisions for the future (Bhattacharya et al., 2020; Stern, 2011, p.354-357).

4.1.3 How to use the revenues from carbon pricing?

The additional revenues from carbon pricing can be put to efficient use. However, the spending targets will differ between countries. Some may choose to invest in fiscal neutrality, which means that the additional funds are spent for instance on reducing labour taxes. This could regenerate the demand for labour and that way increase the income of households which will support the recovery from the crisis (Engström et al., 2020).

The revenues from carbon pricing can also be used in a way that supports the change towards a climate-resilient economy. For example, if the income is spent on green infrastructure investments and clean research and development projects, the reforms could have greater environmental impacts (Engström et al., 2020). These two policies seem to have the highest positive environmental impacts of the recovery measures suggested in figure 4. However, clean infrastructure investments have higher multipliers than the spending on research and development according to figure 4 (Hepburn et al., 2020). The next part of this text explains in more detail why green infrastructure projects are likely to be useful policies in the recovery of the pandemic crisis, especially in countries that need large funds (Bhattacharya et al., 2020).

4.2 Green infrastructure investments

Public investments can be a key element in building recovery measures. Investments are important drivers of long-term productivity and transformation to low-carbon economies. Public investments with high fiscal multipliers, high labour intensity and fast speed of implementation would help to avoid a future debt crisis and to obtain debt sustainability. These features would therefore contribute to governments' fiscal space (Bhattacharya et al., 2020; Koundouri et al., 2020). Investments in re-educating the workforce that has suffered from unemployment due to the pandemic, would be useful in getting citizens back to earning income. In addition, there is evidence that green stimulus measures

commonly have more positive economic impacts than traditionally used fiscal measures (Hepburn et al., 2020). For instance, a study made by Garrett-Peltier (2017) suggests that every 1 million dollars that has been invested into renewable energy infrastructure has created 7.49 full-time-equivalent jobs. When the same amount of money has been spent on fossil fuels, the number of full-time jobs generated was only 2.65 which is almost five workers less. Thus, this study proves what other papers (see e.g., Bowen & Stern, 2010) also suggest: investing in a low-carbon economy increases the demand for labour, especially in the short run.

Since large-scale green infrastructure investments take time to actualize, governments could favour small-scale sustainable infrastructure projects in the early phase of the recovery to increase economic activity. The stimulus is likely to be more effective if it can be implemented rather quickly after the initial negative shock (Bowen & Stern, 2010). These small-scale nature-based investments, like setting up solar panels on houses, can be implemented fast, and that way they can increase low-skill employment. Also, these investments can benefit the local economy more widely if native contractors and suppliers are being used. However, this requires capacity, knowledge and coordination in that specific sector, in the area where the investment is being carried out. The job and growth enhancing characteristics of these green measures would affect positively the local fiscal multiplier and climate goals (Bhattacharya et al., 2020; Engström et al., 2020).

However, these recovery measures can also include long-term investments in renewable energy, green infrastructure and energy storage (Borghesi et al., 2020). These investments have reduced carbon dioxide emissions throughout their existence, and they do not have to face the risk of scarcity like fossil fuel-based investments. Also, public renewable infrastructure investments can further the shift of private investments and human behaviours towards a greener path. Not to mention that policies such as carbon pricing can enhance the shift even more (Engström et al., 2020). Nevertheless, there must be enough green infrastructure to replace the polluting production that is harmful for the environment. Otherwise, the dirty infrastructure will remain in societies. By underinvesting or investing public funds in unsustainable and dirty capital, we might continue being dependent on stranded sources of energy (Bhattacharya et al., 2020).

In addition to positive climate impacts, investments with high future returns, economic multipliers and efficiency are needed as public debt burdens increase and fiscal space tightens. For instance, renewable energy investments require more workforce in the short run, which affects positively the economy. Once the already existing technologies, like solar and wind power, and the new technologies develop

and the economy returns to capacity, the labour force could be reallocated. In addition, the prices of renewable energy are constantly declining. Therefore, the lower costs of clean energy and a more efficient use of workforce can expand the supply. This way the green investments could serve high multipliers also in the long run (Hepburn et al., 2020; Koundouri et al., 2020).

Especially in emerging markets and developing countries, where the centres of growth are predicted to rise rapidly in the years to come, sustainable investment projects could begin rather fast and that way ensure that the cities are built in a green way that supports the objectives of international climate agreements. In light of the impacts of pandemic on public finances discussed in section 2.2.2., financial help from multilateral institutions and banks could also potentially help emerging markets and developing countries to invest in resilient and employment enhancing recovery instruments that would create high fiscal multipliers (Bhattacharya et al., 2020).

4.3 Conditions for bailouts

Conditional bailouts are a stimulus measure that can help firms to avoid bankruptcy, secure employment, sustain a stable base for economic recovery and simultaneously require polluting sectors to become more environmentally friendly. Conditioning public aid to industries can make bailouts more effective and at the same time more align with governments' climate goals (Engström et al., 2020). Fossil fuel industries, that are a major employer for millions of people, are negatively affected by the current crisis. Companies from these industries have had to deal with particularly low oil prices (Ember, n.d.), which has made polluting sectors more likely to ask for public funds (Bhattacharya et al., 2020).

In these circumstances, governments typically have to take immediate action to support viable firms. The underuse of capital and the fall in economic growth is likely to lead to re-educating and relocating the workforce. However, governments may pursue to bailout large firms to avoid bankruptcies and protect employment. The key question is whether public aid for large enterprises should be conditional or not. Regulators would have to have access to information about firms' actions, so the conditions could be individualized and that way the used instruments would be most effective. Also, with access to information about businesses in distress, governments can supervise whether the bailed-out firms have been acting according to the settled conditions or not. Otherwise, there can be a problem of asymmetric information and risks having to do with public aid being misallocated if firms can operate without supervision. Furthermore, governments usually intervene when the businesses have large

market shares because these firms affect more substantially economic growth. The regulators should therefore make sure not to distort competition while bailing out such companies. There can also be trade-offs between environmental efforts and profits for firms if green choices create extra costs. Therefore, firms may be less willing to make green choices but conditions in bailouts might force firms to change their structures (Ing & Nicolaï, 2020).

While adding conditions when bailing out emission-intensive businesses, governments can avoid going back to business-as-usual and develop sustainable and green conditions that would support the structural changes of economies (Hepburn et al., 2020). However, for bailout conditions to succeed they should be appropriate, individualized and able to create credible changes in firms' actions. The industry getting the financial support should be likely to arise after bankruptcy even in the absence of public aid. One accurate example is the airline sector. Due to restriction, traveling has decreased. As airline companies are on the verge of bankruptcy, if they are not bailed out by governments, the assets could be sold to new owners. Once the Covid-19 crisis is under control, the new owners could be able continue to operate on the market again. However, with conditional bailouts the firms and their employees could be saved and at the same time their behaviours could be directed to support the net-zero emission targets (Engström et al., 2020).

In the aviation sector, for example, the conditions can be related to reducing domestic and other short-haul flights and that way attract travellers to use other less emission-intensive options (Engström et al., 2020). Such conditions have already been attached to bailouts directed to the Air France-KLM Group and Austrian Airlines for instance (Bhattacharya et al., 2020). In addition, France has also announced to bailout companies in the automobile industry if they increase investments in electric vehicles as part of the country's plan to make the economy more environmentally friendly and increase its company's competitiveness (Ing & Nicolaï, 2020). This example shows that it is possible to add the environmental aspect to fiscal recovery measures and that way seek sustainable growth.

As the conditions for bailouts are settled, regulators should have access to enough information to ensure that the actions of the bailed-out firms are in line with the contracts. If the firms do not align with the conditions, sufficient sanctions could be put in place that would not tempt companies to violate the commitments. Monitoring can be expensive on governments, but it could be relocated on society. If the bailout conditions are publicly announced, for example politicians and journalist could also be capable of pressurizing firms through mass media. The fear of losing their customers and reputation can encourage companies to commit to their contracts with the government (Ing & Nicolaï, 2020).

5 Conclusion

Negative supply and demand shocks due to the Covid-19 pandemic have created exceptional uncertainty and economic crisis, consequently, lead to growing unemployment and public debt levels. In parallel, the world is facing a climate crisis that can similarly have serious economic consequences, if not addressed. By October 2020, governments had announced 13 trillion US dollars' worth of stimulus and recovery measures. In the design of recovery measures, especially in Europe, policymakers seem to aim at taking both of these crises into account in stabilizing economies.

A green and sustainable recovery from the Covid-19 crisis could be achieved by using a selection of fiscal measures that support employment, economic growth and public finances, while at the same time contribute to climate goals. The effectiveness of fiscal stimulus policies in terms of impacts on growth can be examined through fiscal multipliers. The multiplier typically increases in times of crisis especially when additional public spending is used, for example compared to tax reductions. Overall, the evidence suggests that the multiplier can be applied as a useful tool to compare different recovery policies. This paper also discusses more specific recovery instruments, especially carbon pricing, green infrastructure investments and conditional bailouts as the main stimulus measures in supporting climate goals. The analysis indicates that in terms of nature and magnitude of public spending, investments on clean energy infrastructures or research and development could produce best potential climate impact in the long run. At the same time, such measures increase the demand for labour and enhance growth in the short run.

Generally, it seems that the instant stimulus measures planned so far do not positively contribute to climate. However, the need for very rapid policy responses have left little time to design policies that address climate objectives. Such measures may require structural efforts that can be implemented over a longer time horizon. The analysis and policies discussed in this paper aim at enhancing the understanding about the nature and design of recovery measures with multiple policy targets. The policies suggested in this paper could be considered as part of the general conversation about further recovery measures.

Once the pandemic crisis is over and the restrictions are abolished, a more comprehensive analysis could be conducted about the effectiveness of recovery measures used. Moreover, the analysis on relations between climate impacts and the magnitude of fiscal multipliers could be deepened. This paper can be complemented with further research on the effectiveness of actual recovery measures on climate and economy in reality.

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